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WINTER ANNUAL LEGUMES

for the South

FARMERS' BULLETIN NO. 2146
U.S. DEPARTMENT OF AGRICULTURE

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This bulletin supersedes Farmers' Bulletin 1663, Winter Legumes for
Green Manure in the Cotton Belt.

Washington, D.C.

Issued February 1960

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price 15 cents

WINTER ANNUAL LEGUMES

*for
the
South*

By P. R. HENSON and E. A. HOLLOWELL, research agronomists,
Crops Research Division, Agricultural Research Service

Crimson clover, vetches, lupines, and other winter annual legumes are grown in most of the South.¹ The plants grow during fall, winter, and spring months. They blossom and set seed in the spring and die when the seed matures. Seeds germinate in the fall.

Winter annual legumes vary in fertility requirements, winter hardiness, palatability, and soil adaptation, and in the amount of seed and forage produced. The choice of a species to grow depends on local soil and climatic conditions and on the use to be made of the crop.

Optimum temperatures for rapid growth of winter annual legumes are different for different crops, and range from about 65° to 80° F. Rate of growth declines as the temperature drops. If the temperature is much below 40°,

little or no growth occurs. Unseasonably cold weather may kill the plants, especially if it comes while the plants are making rapid growth. Few species are adapted to the colder parts of the region.

USES

SOIL IMPROVEMENT

Winter annual legumes fit readily into row-crop farming methods as soil-improving crops. They are cover crops during the winter and green-manure crops in the spring.

As cover crops, they protect the soil against leaching, which is most serious on loams and fine sands. Unless soils are protected during the winter, rainfall leaches out plant nutrients that remain after summer crops are harvested. Winter annual legumes save these nutrients by using them in their growth. When the legumes decompose, after being turned under, the nutrients are released for use by the following crop.

¹ Winter annual legumes also are grown in other areas having mild winters. The map on page 15 shows the areas to which this bulletin applies.



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This winter annual legume pasture is moderately grazed. It will provide a good green-manure crop for turning under in the spring.

Like other green-manure crops, winter annual legumes add organic matter to the soil. The added organic matter usually improves the physical condition and increases the water-holding capacity of the soil and helps beneficial micro-organisms to flourish in the soil.

Legume crops also add nitrogen to the soil. Bacteria in the root nodules take nitrogen from the air, and the plants use this nitrogen in their growth. When the crop decomposes, the nitrogen becomes available for succeeding crops.

The large taproots of sweet-clover and the roots of some other legumes improve the soil by mechanical action; they open up heavy soil and improve aeration and drainage.

WINTER GRAZING

Legumes grown to provide winter grazing for livestock may be seeded alone or in mixtures with winter grains or annual grasses. Also, some kinds may be overseeded on permanent pastures of warm-season grasses or on a permanent pasture of tall fescue, a cool-season grass.

Winter legumes overseeded on permanent pastures not only provide high-protein, nutritious feed, but also furnish nitrogen for the permanent grasses to use in their growth. Crimson and persian clover and other true clovers, vetch, sweetclovers, burclovers, and sweet lupines may be overseeded on bermudagrass, dallisgrass, and bahiagrass pastures.

Moderate grazing allows continuous regrowth and does not seriously affect the green-manure value of the crop if it is to be turned under in the spring.

CULTURE

Adapted winter annual legumes usually produce satisfactorily if grown under proper cultural practices. Whether the crops grow in pure stands or with small grains or grasses, they will benefit from proper fertilization, good seedbed preparation, inoculation, and other recommended practices.

FERTILIZATION

Phosphorous and potassium are needed to successfully grow winter annual legumes on poor soils. Commercial fertilizers containing these minerals are most commonly used; the amount depends on natural fertility and previous soil treatment. Most applications are made with such formulations as 0-10-20 or 0-10-30, and are in the range of 300 to 600 pounds per acre.

Apply fertilizer in the fall just prior to seeding the legume or at the time of seeding.

Lime at the rate of 1 to 2 tons per acre may be needed for the production of certain legumes.

Most State agricultural experiment stations maintain soil-testing laboratories and will test soils to determine the amount of lime and fertilizer needed.

INOCULATION

Inoculation is essential for profitable production of all legumes. Inoculated plants are easily recognized by their dark green color and vigorous growth, and by the abundance of nodules on the roots. Lack of inoculation causes many failures.

Plants are inoculated by specific strains of bacteria that infect the roots and form nodules. These bacteria obtain gaseous nitrogen from the air and fix it in a non-gaseous state in the nodules. Nitrogen produced this way is used by the growing plant. After the plant dies the nitrogen is released and becomes available for the growth of succeeding crops.

Legume plants may be inoculated either naturally or artificially. They are inoculated naturally when they are planted in soil that contains the right strains of bacteria. They are inoculated artificially when pure cultures of bacteria are added to the seed, or when soil in which legume crops have grown is mixed with the seed.

Artificial inoculation of seeds with selected strains of bacteria is recommended. Inoculation with soil is not recommended because it is impossible to know whether soil contains the right kind of bacteria in sufficient numbers. Also, soil used for inoculation may spread diseases and weed seeds.

Legume bacteria are grouped according to the legumes they inoculate. Bacteria in each group

inoculate only those legumes for which they have been cultured. For example, bacteria that inoculate burclovers will not inoculate crimson clover or lupines.

The four bacteria groups that inoculate winter annual legumes, and the legumes inoculated by each group, are as follows:

Alfalfa group.—Black medic, all the burclovers, buttonclover, sourclover, and sweetclovers.

Clover group.—Ball, berseem, cluster, crimson, bigflower, hop (large and small), lappa, persian, rose, and striate clovers, and subclover.

Pea and vetch group.—Roughpea, Tangier pea, all the vetches, and winter field pea.

Lupine group.—Blue, white, and yellow lupines, and serradella.

For additional information on legume inoculation, consult your county agent or State agricultural experiment station, or write to the U.S. Department of Agriculture, Washington 25, D.C.

SEEDBED PREPARATION

The amount of soil preparation necessary to get a good seedbed depends on the legume to be seeded, culture of the previous crop, soil type, and environmental conditions.

Small-seeded legumes such as clovers require well-prepared seedbeds. Winter field peas, vetches, lupines, and other large-seeded legumes require less seedbed preparation than the small-seeded legumes.

You can prepare well-drained loam and sandy soils following cotton, soybean, or peanut crops

by disking the soil in both directions and following with a cultipacker to firm the seedbed. If there is a heavy vegetative growth, plow before disking, regardless of soil type.

If you plant on a permanent sod, clip the grass closely or permit livestock to graze it closely at planting time. An excess of vegetative growth prevents the establishment of seedling plants.

If a late summer drought makes soil too dry for a seedbed to be prepared at the normal time, the job may have to be delayed until after the first good rain.

SEEDING

Method

Seed may be broadcast, but seeding with a grain drill, roller-seeder, or similar implement usually results in more uniform stands. Drilling requires less seed than broadcasting, and thoroughly prepared seedbeds require less seed than rough, poorly prepared ones. Sod-seeding drills are available for overseeding on permanent pastures.

Large-seeded winter legumes are often seeded in standing cotton before all the cotton has been picked. Where the cotton stalks are short the seed may be drilled in the middles. Where cotton is extremely rank growing, seeding is best done immediately after the last picking. The seed may be broadcast by hand or by airplane and covered with cultivators, harrows, or listers.

Mature seed pods of many

kinds of winter annual legumes shatter and spread seeds on the ground. If the shattered seeds are hard, they remain dormant during the summer months and germinate in the fall (hard seeds have a seedcoat that delays sprouting). Kinds that produce a high percentage of hard seeds will volunteer good stands year after year, if they are in permanent pastures and are properly managed.

If you use legumes for green manuring, you will have to plant seed for each crop. If you grow kinds that do not have hard seed, you will have to seed each fall regardless of use.

Time of seeding

The best time to seed varies with latitude and seasonal conditions, and with the use to be made of the crop. If the crop is to be used for winter grazing, early seeding is desirable because it gives the crop more time to make fall growth. However, where nematodes are numerous they may damage unusually early seedlings. Also, damping-off diseases of seedlings are more severe under warm and moist conditions, which are common in the South in late summer and early fall.

The amount of fall growth is directly related to the date of planting. Seeding too late in the fall results in poor plant cover, reduced winter grazing, increased winter injury, and lower yields in the spring.

The map on page 15 shows the zones of adaptation for winter annual legumes. The zones are

based on average annual minimum temperatures. The following list shows zones, crops adapted to each zone, and recommended seeding dates.

ZONE A

October 1 to October 31.—Serradella and Tangier pea.

October 1 to November 15.—Blue, white, and yellow² lupines; bigflower, common, hairy, Hungarian, monantha, narrowleaf, purple, smooth, and woollypod vetches; and winter field peas.

October 15 to November 15.—Black medic, annual sweetclovers, ball, bigflower, cluster, crimson, hop, lappa, persian, rose, striate, and subclovers.

ZONE B

September 15 to October 15.—Black medic; California, cogwheel, spotted, and Tifton burclovers; buttonclover; blue² and white lupines; and ball, bigflower, cluster, crimson, hop, lappa, persian, rose, striate, and subclovers.

October 1 to October 31.—Roughpea; bigflower, common, hairy, Hungarian, monantha, narrowleaf, purple, smooth, and woollypod vetches; and winter field pea.

ZONE C

September 1 to September 30.—Black medic, spotted and Tifton burclovers, buttonclover, and crimson and hop clovers.

September 15 to October 15.—Roughpea; winter field pea,² bigflower, common, hairy, Hungarian, monantha, narrowleaf, purple, smooth, and woollypod vetches.

ZONE D

August 15 to September 1.—Crimson clover.

August 15 to September 15.—Black medic and buttonclover.

September 1 to September 30.—Hairy and smooth vetches.

² Adapted only in southern part of zone.

Moisture conditions

Over much of the region some of the year's driest weather occurs in the fall, and it may be necessary to adjust seeding dates to moisture conditions. Don't seed in dry soil. If dry weather delays the operation, prepare seedbeds and seed immediately after the first good rain. A portable irrigation system will help solve the moisture problem in dry months during the fall. If irrigation equipment is used on other crops, it may also be used profitably on winter legumes. Irrigated crops usually provide grazing over a longer period than unirrigated crops.

Fallowing the soil a month to 6 weeks before planting time to control weeds and thereby conserve moisture may be a desirable practice in areas where autumn rainfall usually is inadequate.

In the central and south-central parts of the region, rainfall during winter months usually is excessive and drainage may become a problem. This is particularly true on the level heavy soils of the Mississippi Delta. Drainage can be provided for a green-manure crop planted in such a soil by broadcasting the seed, then covering it with a middle-buster (lister) set at a shallow depth. This operation throws soil and seed into beds and at the same time provides water furrows for drainage. A number of drill seeders have been devised that plant and at the same time leave water furrows for drainage.

Rate of seeding

Recommended seeding rates for winter annual legumes are as follows:

	<i>Pounds per acre</i>
Annual medics:	
Black medic.....	10-15
Burclovers:	
California	15-20
Cogwheel.....	15-20
Spotted.....	(¹)
Tifton.....	(²)
Buttonclover.....	15-20
Annual sweetclovers.....	10-12
Lupines:	
Blue	60-90
White.....	90-120
Yellow	50-80
Roughpea	50-60
Serradella.....	15-20
Tangier pea.....	60-70
True clovers:	
Ball	4-7
Berseem.....	12-18
Bigflower.....	4-7
Cluster.....	4-7
Crimson.....	15-20
Hop	3-5
Lappa.....	5-10
Persian	4-7
Rose.....	10-15
Striate.....	5-10
Sub.....	20-30
Vetches:	
Hairy	20-30
Smooth.....	20-30
Woollypod	25-35
Common.....	40-50
Hungarian.....	40-50
Monantha	30-40
Narrowleaf.....	20-30
Bigflower.....	35-40
Purple	40-50
Winter field peas.....	30-40

¹ 5 to 6 bushels of unhulled seeds in the bur.

² 4 to 5 bushels of unhulled seeds in the bur.

Under favorable conditions, use the minimum quantity of seed. Under unfavorable conditions, increase the quantity. In seeding

mixtures, use three-fourths as much legume as is recommended for seeding pure stands and use one-half as much companion grass or grain as is recommended for seeding pure stands.

For overseeding in permanent grass, use the seeding rates listed above.

TURNING UNDER

The effectiveness of winter legumes in increasing yields of succeeding crops depends on the amount of organic matter and nitrogen added to the soil by turning under the legumes.

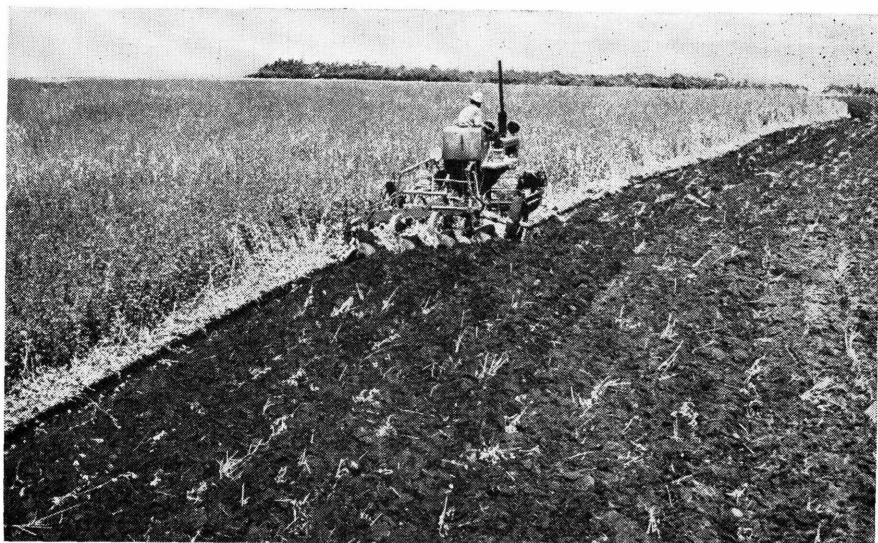
In general, the green-manure value of a crop increases along with increased growth—as long as the crop remains green and succulent. Much of the value of a green-manure crop is lost if it is turned under too early in the

spring, before it has a chance to make good top growth. Overgrazing during the late winter and early spring holds back growth and reduces green-manure value. On the other hand, don't let the crop get too mature before you turn it under. A green, full-grown crop may contain 100 pounds or more of nitrogen per acre and 2 tons or more of organic matter.

Green, succulent legumes should be turned under 3 or 4 weeks before the succeeding crop is planted. Allow a longer decomposition period for more mature crops.

GRAZING

You must properly manage winter annual legumes to get maximum return from grazing. Overgrazing lowers yields. Rotational



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Throughout the winter this sweetclover crop has protected the soil from erosion and prevented leaching of nutrients. Now it improves the soil by providing organic matter and nitrogen.

grazing of three or more pastures usually results in better utilization and greater returns. If grazing is continuous, stock the pastures so that 2 to 4 inches of growth is left at all times. If the stock is rotated, allow each pasture to recover for 3 to 4 weeks after each grazing period.

Pure stands of crimson clover, roughpea, buttonclover, persian clover, and some lupines and vetches make excellent winter and early spring grazing in areas where adapted.

Legume-winter grain mixtures or legume-ryegrass mixtures generally are more productive and are better balanced forages than a single species. A mixture provides some insurance that one of the crops will become established under adverse conditions. Desirable mixtures include crimson clover with ryegrass or winter oats, vetch with oats or Abruzzi rye, roughpea with ryegrass, and buttonclover with ryegrass.

SEED PRODUCTION

Many factors can influence the quantity and quality of seed produced. These include: type and amount of plant growth, number of blossoms, uniformity of seed maturing, shattering or nonshattering of mature seed, ease of hulling, seed moisture content, whether or not the legume requires cross-pollination, and the timing of each cultural operation. Differences among winter annual legumes with respect to these factors are so great that each crop

must be handled differently. Only general procedures and methods are described here. For specific recommendations, consult your county agent, State agricultural experiment station, or experienced growers.

FERTILIZATION

Do not expect large seed yields unless you apply enough fertilizer for good growth. In some soils the application of minor elements such as boron may be essential for seed setting, but not for forage production. Follow fertilizer recommendations of your State soil testing laboratory. If a crop being grown for seed is grazed, remove livestock and clip the crop at least 6 weeks before the normal time of blooming so that all plants will be uniform in growth.

POLLINATION

Most clovers and vetches require insect pollination. Seed yield in these crops usually is increased by supplying at least one strong colony of bees per acre. Place them on the edge of the field or in the field when the first flowers appear.

HARVESTING

For crimson clover and vetch crops and others that have a long flowering period or shatter readily at maturity, start harvesting when about three-fourths of the seed pods have turned brown and the seed can be readily hulled. Defoliation, a standard practice in arid regions of the West, is risky



Cutting and swathing in one operation, with a windrowing attachment on the mower, held seed shattering to a minimum in this crimson clover crop. Combining from the windrow, rather than hauling or bucking to a stationary thresher, also reduced shattering.

if the weather is humid and showers are likely. The crop must be harvested shortly after defoliation. The entire seed crop may be lost if harvesting is delayed.

A seed crop may be combined direct if it is dry. The crop can also be combined from swaths or windrows. Crops that are difficult to thresh or hull may have to be hauled or bucked to a combine used as a stationary machine and threshed twice. Swathing or windrowing is recommended for crops that shatter readily or have a large amount of green stems and leaves.

During rainy weather, seed losses usually are less in swathed

crops than in windrowed crops. If the crop is to be swathed or windrowed, cut it early in the morning when the seed pods are damp with dew. If crops that shatter readily are windrowed, seed loss usually can be reduced with a windrow attachment on the cutter bar. A short weed bar with sickle guards removed reduces choking of the sickle bar in tangled or lodged growth. Allow swathed or windrowed crops to dry before threshing.

Before combining a legume crop, adjust the reel, cylinder, and concaves to reduce seed damage and losses in the tailings. To do a good threshing job, have the crop

as dry as it can get without shattering. Also carefully control the forward speed of the combine to prevent losses. The operator's manual gives recommendations for your combine.

HANDLING

Drying the seed after harvesting usually is necessary to get and maintain high germination. If a drier is not available, thinly spread the freshly harvested seed under shelter and turn every day until the seed is dry. Before drying large-seeded legumes such as lupines, clean the seed to remove green trash and immature seed. To improve the quality of small-seeded legumes, rough-screen the stems, hulls, and immature seed from the good seed as soon as possible after drying.

Thoroughly clean all harvested seed as soon as possible.

INSECTS³

Several insect pests seriously damage winter annual legumes. The pea aphid infests clovers, vetches, winter peas, and most of the other common legumes. If vetches and peas are left growing too late in the spring, pea aphid damage may cause complete failure. Pea aphids cause severe stunting and yellowing.

Larvae of the cloverleaf weevil feed on several species of legumes and may cause considerable leaf loss. A fungus disease usually holds this insect in check.

The lesser cloverleaf weevil feeds on the stems, buds, florets, and seeds of many clovers. A species closely related to the lesser cloverleaf weevil feeds in the heads of clovers. Larvae of these

³ Contributed by the Entomology Research Division.

COMMON AND SCIENTIFIC NAMES OF INSECTS

Pea aphid.....	<i>Macrosiphum pisi</i>
Clover leaf weevil.....	<i>Hypera punctata</i>
Lesser clover leaf weevil (and a related species with no approved common name).	<i>H. nigristrotris</i> and <i>H. meles</i>
Garden webworm.....	<i>Loxostege similalis</i>
Lygus bugs.....	<i>Lygus</i> spp.
White-fringed beetles.....	<i>Graphognathus</i> spp.
Root weevil on lupine (no approved common name) ..	<i>Sitona explicita</i>
Lupine maggot.....	<i>Hylemya lupini</i>
Flower thrips (and a related species with no approved common name).	<i>Frankliniella tritici</i> and <i>F. bispinosa</i>
Vetch bruchid.....	<i>Bruchus brachialis</i>
Corn earworm.....	<i>Heliothis zea</i>
Alfalfa weevil.....	<i>Hypera postica</i>
Spotted alfalfa aphid.....	<i>Therioaphis maculata</i>

two insects severely damage crimson clover crops grown for seed.

The garden webworm, which attacks several legumes, is especially destructive on young seedlings in the fall. Several cutworms are destructive at times. Leafhoppers feed on many different legumes, causing the leaves to turn yellow, red, or brown. Lygus bugs may be pests of legume crops grown for seed. White grubs and larvae of white-fringed beetles may damage roots of most winter legumes.

A root weevil may reduce lupine stands. Larvae of the lupine maggot feed on tender buds, stunt the plants, and reduce seed yields. The flower thrips and another thrips species cause stunting, poor bloom, and early defoliation of lupines, especially the sweet variety Borre blue. Grasshoppers sometimes destroy seedling fields of lupines.

Larvae of the vetch bruchid infest vetch seeds and reduce yields. Damage from this pest is more severe on hairy, woollypod, purple, and Carolina native vetches than on other vetches. Corn earworms sometimes severely damage hairy vetch late in the spring.

The alfalfa weevil is mainly a pest of alfalfa, but larvae attack and may defoliate black medic, burclovers, and buttonclover.

The spotted alfalfa aphid feeds on and may damage alfalfa, black medic, burclovers, and sourclover.

For information on how to control insect pests of winter legumes, consult your county agent or State agricultural experiment station,

or write to the U.S. Department of Agriculture, Washington 25, D.C.

DISEASES⁴

Some winter annual legumes are subject to destructive diseases. A few of the most important ones are discussed here.

Leafspots caused by fungi occur on many of the burclovers. Among the most common are a *Cercospora* leafspot of spotted burclover and *Pseudopeziza* leafspot of black medic. The rust fungi are most common on California burclover and black medic. Nearly all the annual medics are susceptible to one or more virus diseases. Little is known about the identity and destructiveness of these diseases.

Annual sweetclovers are susceptible to some of the same destructive diseases that attack the perennial sweetclovers. Among these are blackstem, root rots, and virus diseases. Little is known concerning comparative resistance of annual sweetclovers to the different diseases.

Of the diseases that occur on annual true clovers, those of crimson clover have been studied most extensively. One of the most destructive is sclerotinia crown rot. This fungus attacks plants mainly during the winter months, when moisture is adequate. In a few days the fungus may spread and kill large patches of plants. It can also attack many other species of

⁴ Prepared by K. W. Kreitlow, research pathologist, Crops Research Division.

DISEASES AND CAUSAL ORGANISMS

<i>Cercospora</i> leafspots.....	<i>Cercospora medicaginis</i> and <i>C. zebrina</i>
<i>Pseudopeziza</i> leafspot.....	<i>Pseudopeziza medicaginis</i>
Rust	<i>Uromyces striatus</i> var. <i>medicaginis</i>
Black stem.....	<i>Mycosphaerella lethalis</i>
Root rots.....	<i>Fusarium</i> and <i>Rhizoctonia</i> spp.
Crown and stem rot.....	<i>Sclerotinia trifoliorum</i>
Sooty blotch.....	<i>Cymadothea trifolii</i>
Powdery mildew.....	<i>Erysiphe polygoni</i>

plants including alfalfa and perennial clovers.

A leafspot caused by *Cercospora* species of this fungus is widespread and sometimes destructive on crimson clover and hop clovers. Sooty blotch is a common fungus disease that sometimes defoliates crimson clover. Powdery mildew, which resembles flour dusted on leaves, is widespread but not destructive to the hop clovers and crimson clover. Several virus diseases occur on crimson clover and many other annual species.

There are no adequate measures for controlling the destructive diseases of winter annual legumes. However, rotation with nonsusceptible crops, use of adapted varieties, and good cultural practices can reduce damage. Some resistant varieties have been developed and are recommended where adapted.

KINDS OF LEGUMES

Following are brief descriptions of winter annual legume species adapted to the region shown in the map on the next page. For more information con-

sult your county agent or write to the U.S. Department of Agriculture, Washington 25, D.C.

ANNUAL MEDICS

A number of species of the genus *Medicago* are well adapted to various parts of the region. All are reseeding annuals and will volunteer for many years under proper management.

Black medic.—Closely related to the burclovers. Makes little fall and early winter growth, and is therefore rarely used solely for soil improvement. Used in mixed permanent pastures on the heavier soils throughout the region. Winter hardy in the entire region. Particularly noticeable in permanent pastures in springs following severe winters when less hardy legumes have winterkilled.

Burclovers.—Grow well on reasonably fertile loams and well-drained clay soil. Grow best on soils rich in lime but also succeed in somewhat acid soils. Used for pasture and soil improvement. Farm animals do not eat burclover readily at first but soon acquire a taste for the plant and then eat it freely.

All burclovers are similar in appearance. They have small yellow flowers that produce coiled pods. The spines that beset the pods on most kinds form the so-called burs.

Spotted, or southern, burclover is widely grown on the heavier soils throughout zone B and in the southern part of zone C. It volunteers throughout the Mississippi Delta.

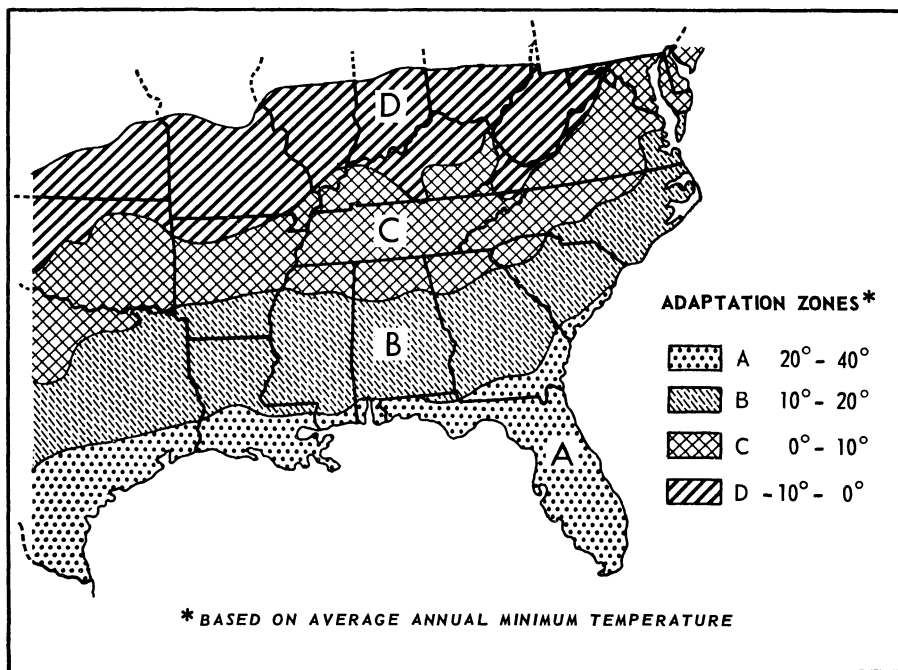
California burclover is used to a limited extent. Most of the acreage is in the southwestern part of the region. It is less hardy than spotted burclover. It is adapted to the heavier soils of zone B.

Tifton burclover is of more recent origin. While it is somewhat more winter hardy than

spotted, it is not widely grown. It is similar to spotted burclover but lacks the characteristic dark purple spot in the middle of each leaflet.

Cogwheel burclover is so named because of the "cogwheel" appearance of the bur. In contrast with the pods of the other burclovers, cogwheel pods are spineless. It is recommended for pasture in the east central area of Texas. It is preferred over other burclovers for sheep pasture because it is spineless.

Buttonclover.—So named because of its flat, coiled, spineless, button-shaped seed pods. One of the more important annual medics for hay, pasture, and soil improvement. Well adapted to the loams and well-drained clay soils rela-



Zones of adaptation for winter annual legumes.

tively high in lime in zones B and C. Usually seeded in mixtures with ryegrass, oats, and other winter-growing grasses; greatly increases the nutritive value of the crop for hay or pasture. Re-seeds readily where adapted. For sheep pasture it has the same desirable characteristic as cogwheel burclover—spineless pods.

ANNUAL SWEETCLOVERS

Sweetclovers include a n n u a l and biennial species and annual forms of the biennials. They are introduced plants. Only the three kinds described below are important in the South as winter annuals.

Sweetclovers contain a substance called coumarin that gives a vanilla-like odor and a bitter taste. Usually animals must acquire a taste for sweet clover before they freely graze it. Feed only well-cured sweetclover hay to livestock because improperly cured hay may contain a coumarin decomposition product that causes the bleeding disease of cattle and sheep. Sweetclover makes excellent silage, but it must be properly preserved to prevent toxicity.

Production is limited to alkaline soils or to soils on which limestone or marl has been applied. Sweetclover is widely adapted to high, dry, sandy soils or heavy clay and is one of the outstanding legumes for green manure.

Annual white sweetclovers.—The two varieties used extensively are Hubam and Floranna. Israel, released in 1958, is much later in

maturity than Hubam and Floranna. Its range of adaptation has not been fully determined. It makes rank growth in the coastal section of Texas during the spring and early summer months, but less winter growth than the others.

Hubam is widely used for soil improvement and grazing in zones A and B. Leaf and stem characteristics are similar to those of sourclover. Florets are white and more loosely attached to the flower stem than are sourclover florets. Seeds are yellow, hard, and about the same size as red clover seed. In the northern part of zone B, stands from fall seedings may be frequently killed either by freezing or from heaving. Seed volunteers to good stands in the fall if the plants are not closely grazed at time of flowering and seed setting.

Floranna makes slightly more winter and early spring growth than Hubam. Plant and seed characteristics and range of adaptation are similar to those of Hubam. Since Floranna seed cannot be distinguished from Hubam seed, use certified seed to insure varietal purity and performance.

Sourclover.—This is the only true winter annual sweetclover. Adapted to zone A. Not winter hardy enough for planting farther north. The leaf is composed of three slender leaflets toothed in the tip end, with the center leaflet prominently stalked. A crushed leaf or stem gives a coumarin odor

and tastes bitter. The yellow, somewhat inconspicuous florets are borne in loose clusters along the flower stem. The dull, olive-green, hard seeds are smaller than those of white sweetclover seeds. Although sourclover is grazed, it is most valuable for green manure.

LUPINES

Lupines, where adapted, are productive winter annual legumes. Generally lacking in winter hardiness, they are adapted only to areas having mild winters. Lupines grow best on sandy or well-drained loam soils of moderate fertility. They give excellent yields of forage and seed; are suitable for pasture, silage, or soil improvement.

Three species—blue, white, and yellow—have become important winter annuals in the lower South. All were introduced from Europe. They are upright in growth and have coarse stems and medium-sized, fingerlike leaves.

Blue lupines.—Two types are grown in the region: (1) Bitter, or poisonous high-alkaloid, varieties, and (2) the sweet, or low-alkaloid, varieties. Hardier than yellow lupines. Widely grown in zone A and in the lower eastern part of zone B. Yields of 2 to 3 tons per acre of dry herbage containing 100 to 150 pounds of nitrogen are not uncommon. Bitter type used solely for soil improvement. The sweet (low-alkaloid) varieties, Borre and Blanco, are nonpoisonous and suitable for winter grazing as well as for soil improvement. For winter graz-

ing they may be seeded alone or in mixtures with oats or rye.

White lupines.—Not widely grown. Most winter hardy of the three species; adapted in zone B. Bitter. Suitable only for soil improvement.

Yellow lupines.—Generally less winter hardy than blue and white species. Particularly well adapted to north Florida. Limited adaptation in southernmost parts of Georgia, Alabama, and Mississippi. White-seeded sweet variety is the most widely grown of the yellow varieties and is used both for grazing and for soil improvement.

For more information on culture and use of lupines, consult your county agent or State agricultural experiment station, or write to the U.S. Department of Agriculture, Washington 25, D.C.

ROUGHPEA

Roughpea also is known as Singletary, Wild Winter, or Caley, pea. It is a weak-stemmed plant similar to vetch and field peas. It makes much less winter growth than most winter legumes, but is an excellent crop to grow if you desire early spring growth.

Roughpea is especially well adapted to heavier soils. Once established on such lands, it re-seeds annually under proper management. In many johnsongrass areas, roughpeas regularly volunteer and provide excellent winter and early spring grazing. By adding to the soil nitrogen supply,

the crop also increases the yield of the johnsongrass for pasture and hay.

Roughpea seed is poisonous. Remove livestock from fields when the pods begin to form. Animals become stiff or lame when poisoned but soon recover when placed on other pasture.

SERRADELLA

Serradella is a many-branched, slender-stemmed annual legume with vetchlike leaves. It is primarily adapted to moist sandy to loam soils. It makes good growth on soils deficient in lime. In general, it is not as productive as the vetches, lupines, and other winter legumes. Little is grown in the United States.

TANGIER PEA

The general growth habit of the Tangier pea is similar to that of the common sweetpea. It lacks winter hardiness and grows only in zone A. It grows rapidly at moderate temperatures but it has not been as productive as vetches and field peas in its zone of adaptation.

TRUE CLOVERS

Leaves of most true clovers are composed of three leaflets. Leaflets are sessile (not stalked) on true clovers except large and small hop clovers. Only the true winter annual kinds of agricultural importance are discussed in detail below. In addition to these true winter annuals, several perennial kinds such as red, white, and alsike clovers may behave as

winter annuals under certain environmental conditions.

True clovers thrive under cool, moist growing conditions. They benefit from the application of limestone, mineral fertilizers, and minor elements when these are deficient. All are excellent pasture plants and those making more upright growth are also good for green manuring, hay, and silage. During the fall and early winter months all kinds make a rosette-type growth. With the approach of spring, flower stems develop and they bear flower heads composed of individual flowers called florets.

Seed of the most important winter annual true clovers can be purchased from the seed trade but some kinds are available only from farmer growers.

Ball clover.—Has a wide range of adaptation in zones A and B. A prolific seeder that persists under low soil fertility levels. A good pasture plant, but grazing season is short.

Leaflets are similar to white clover leaflets, but edges are more strongly toothed. Flower heads are round, white, sometimes turn pinkish as the seed is forming. Florets reflex, or turn down, when head matures. Seeds are yellowish to brownish.

Berseem clover.—Not winter hardy. A temperature of 26° F. has killed stands of rapidly growing plants. Lack of winter hardiness restricts range of adaptation. Under favorable temperatures, seed germinates rapidly and it

makes more winter growth than any other species. It can be grazed, but is better for hay, soil-ing, or green manure.

Leaflets are longer than broad. Leaves and stems are sparingly covered with hairs that lie flat along the surface. Flower heads are yellowish, oblong. Seeds are yellow and about the size of red clover seeds.

Big flower clover.—Best adapted to zone A and the southern part of zone B. Has been successfully used as a grazing plant. However, tall growth and large, coarse, hollow stem makes it susceptible to trampling injury, especially in flowering and seed-setting stages. Produces a large growth and appears to be a good silage and green-manure crop. Most plant and flower characteristics are similar to those of alsike clover. Seed is yellowish brown.

Cluster clover.—Somewhat restricted in adaptation to zone A and especially to soil and climatic conditions of southern Mississippi. A good pasture plant, but relatively short productive forage period.

Leaflets are similar to ball clover leaflets, but generally have a small brownish spot in the center of the leaflet when young. Heads are small, reddish and inconspicuously located in angles where leaves join stems. Seeds are dull yellow.

Crimson clover.—A nutritious, highly productive grazing plant relished by all classes of livestock. Seldom causes bloat. Does not

require high fertility level for good growth. Not adapted to high, dry, sandy soils or to poorly drained heavy clay. The latter soils remain cold and wet during winter months. Susceptible to crown rot disease, but injury can be minimized by grazing off the lush growth. Seed shatters readily when ripe and care must be taken in harvesting to avoid shattering loss.

Easily identified by bright-crimson, pointed flower heads. Seeds are yellow; approximately 150,000 per pound. Hairy leaflets are broadly oval with blunt tips. Makes dense, rosette-type growth during fall and winter months. Flower stems develop in early spring. Flower heads composed of 50 to 125 florets, each of which may bear 1 seed.

Common crimson clover does not have hard seed; it does not re-seed to produce volunteer stands. Reseeding varieties have been developed. The five most widely used are Dixie, Auburn, Autauga, Chief, and Talladega. Dixie, Auburn, and Autauga are about a week earlier in maturity than Talladega and Chief and produce slightly more winter growth. There are other reseeding strains not as widely used as these five. All reseeding varieties produce a high percentage of hard seed and volunteer good stands in the fall from seed shattered the previous spring.

Use certified seed of a named variety to insure performance and trueness to variety.

Hop clovers.—There are three species of hop clover: Hop clover, large hop clover, and small hop clover. Hop clover is seldom found in thick stands. It is more prevalent in the mountainous sections of the Southern States than in other areas. Large hop clover produces larger yields than small hop clover under favorable conditions, but will not tolerate unfavorable soil and climate and low fertility levels as well as small hop clover. Both large and small hop clovers are valuable pasture plants, particularly for thin, eroded soils. Neither produces much grazing during the winter.

All three species have small, round heads of yellow flowers which turn light brown as the seed ripens. Mature seed head looks like a miniature flower of the hop plant. This is probably the origin of the common name, hop clover. The three species look somewhat alike. Hop clover has slightly larger flower heads and generally has more flowers than the other two. Outstanding difference in leaves of the three species is that middle leaflet of hop clover is not stalked; it is stalked in large hop clover and small hop clover. Observable differences between large and small hop clovers are mainly in the size of the plant, as the common name implies.

Lappa clover.—Best adapted in zones A and B to low-lying, dark-colored, heavy, wet soils that are relatively shallow and have a marl or limestone outcrop. Primarily a grazing plant. Does not have a

wide area of use. All classes of livestock relish it in the succulent growth stage. Stems become fibrous and harsh as plants approach maturity. Tough hulls enclose the mature seed and make threshing difficult.

Reddish florets are small and inconspicuous. Maturing heads are burlike in shape and texture. Seeds are yellowish to light brown and about three times larger than white clover seed.

Persian clover.—Best adapted to low-lying, heavy, wet soils in zone A and in the southern part of zone B. Makes more growth in late winter than white clover of same age and furnishes more late winter grazing. An excellent grazing plant, but appears to cause bloat more readily than any other true clover. Makes high-quality silage if cut when early flowers are mature. Seeds are hard; the crop readily volunteers in fall following spring seed harvest.

Leaflets somewhat like white clover leaflets but slightly less broad and longer. Has light purple flowers and distinctive seed pods. As seed matures the tissue around seed becomes inflated and forms miniature balloons that readily shatter when mature. Seed pods float in water and may be blown about by wind. Mature seeds are glossy and slightly larger than white clover seeds. Most mature seeds are olive green; some are yellow.

Rose clover.—Widely adapted to well-drained sandy loam to clay

soils in zones A and B. Makes good growth under a moderate fertility level. Used for pasture and makes good silage. Dense hairiness of the stems and leaves tends to make a dusty hay. Rose-colored flower heads are about the size of red clover flower heads. Seeds are yellow, hard, and slightly smaller than red clover seed.

Striate clover.—Appears to grow best in heavy clay soils of zones A and B. Stems become harsh and fibrous as plants reach flowering stage, making it less palatable than other species. As seeds mature the heads become stiff and burlike, making threshing somewhat difficult. Principally a pasture clover; readily grazed in the succulent stage.

Seeds are yellowish brown. Leaves and stems are hairy, the leaflets slightly toothed. Flower heads are inconspicuous and reddish.

Subclover.—One of the most promising clovers for pastures in zones A and B. Some plantings have persisted by volunteer seedling for many years. It seems best adapted to well-drained sandy loam and clay soils. Varieties better adapted than those now available would further extend the usefulness of this species under conditions in Southern States. Varieties of subclover differ in many leaf, flower, and seed characters, and in time of maturity. The midseason and late maturing varieties, Mount Barker, Tallarook, and Nangeela, seem to be the best

adapted to the climatic conditions of the South. All kinds of livestock relish this plant. Reseeding is practically certain even under close grazing.

Leaves of subclover are similar to crimson clover leaves. Flower stems develop in late winter and spring and lie on the soil surface. Flower heads have from 3 to 10 loosely attached, whitish florets that remain hidden beneath the thick canopy of leaves. As the seed forms, appendages pull it into the soil. This growth characteristic gives rise to the common name, subclover. The large, black seeds, approximately 60,000 to the pound, are difficult to harvest because most of them are buried in the soil.

Less important true clovers are Carolina clover, buffalo clover, and rabbitfoot clover. Carolina clover is widely distributed and most frequently seen in lawns and on road shoulders. It is frequently seen in pastures of low fertility. It makes only a short growth, blooms, sets seed and dies relatively early in the spring. The flowers give a purplish-red cast to the turf. *Trifolium bejariense*, a species without a common name that is similar to Carolina, is found mainly in the eastern part of Texas. Buffalo clover is widely distributed as scattered plants. The most readily observable characteristic is the large, light-brown maturing seed head with reflexed, or turned-down, florets. They give the plant an umbrellalike appearance. Rabbitfoot clover has

narrow leaves, inconspicuous florets, and longish, grayish heads that have a silky appearance. It usually grows on poor sandy soils.

VETCHES

Vetches are extensively used for cover and green-manure crops. They are also excellent forage plants for pasture and hay. There are many kinds of vetches; the best kind to grow depends on environmental conditions and, to a lesser extent, on the use to be made of the crop. For more specific information, consult your county agent or State agricultural experiment station, or write to the U.S. Department of Agriculture, Washington 25, D.C.

Hairy vetch.—Most winter-hardy vetch. Well adapted throughout the region. Viny stems are comparatively weak; ascend only with support. Usually does not make as much winter growth as less hardy species, but in zone A or in unseasonably warm winters in other zones, it may yield as heavily as less hardy species.

Madison vetch, a variety of hairy vetch, is well adapted to the region.

Smooth vetch.—Not as winter hardy as hairy vetch, but does not ordinarily winterkill. Makes some growth at temperatures low enough to keep hairy vetch dormant. Well adapted throughout the region and frequently is more productive than hairy vetch.

Hairy vetch and smooth vetch are excellent for soil improvement

and winter grazing. They also may be overseeded on permanent summer pastures.

Hairy vetch seed cannot be distinguished from smooth vetch seed; both are sold as hairy vetch seed. In growth, however, varieties are distinct. Hairy vetch has long hairs on stems and leaves; smooth vetch has fewer and less conspicuous hairs. Tufted growth at the end of hairy vetch stems is also characteristic.

Woollypod vetch.—Auburn, Oregon, and Lana are the three varieties. All are adapted to zones A, B, and C. They may be used for soil improvement and winter grazing.

Looks so much like smooth vetch it is difficult to tell growing plants apart. Flower of woollypod is a little smaller and a little deeper red than smooth vetch flower. Seed is readily distinguished from hairy vetch or smooth vetch seed. Seed is oval; hairy vetch seed is nearly spherical. A groove along the dividing line of the seed scar is not present in either hairy or smooth vetch.

Common vetch.—Less winter hardy than hairy vetch and sometimes winterkills. Generally recommended for zones A and B and makes good early growth there. Willamette vetch, a variety selected from common vetch for winter hardiness, is superior to common vetch for general use. Other varieties imported from Europe usually have lacked winter hardiness. A semivining plant that has slightly larger

leaves and stems than hairy and woollypod vetches.

Warrior is a new variety of common vetch developed in Alabama.

Hungarian vetch.—More winter hardy than common vetch; not as winter hardy as hairy vetch. Well adapted to the heavier soils of zones B and C. In general, not as productive as hairy, common, or woollypod vetches.

Much less viny than hairy and common vetches. Covering of medium long hairs gives plant a distinctly grayish color. Plants in flower readily distinguishable from other species by clusters of cream-colored flowers.

Monantha vetch.—Has finer stems and leaves and matures earlier than other cultivated vetches. Lacks winter hardiness but is well adapted in zone A. In this zone it is a good forage and green-manure crop. Bears flowers singly; most other vetches bear flowers in clusters.

Narrowleaf, or Augusta, vetch.—Has high percentage of hard seed; volunteers from year to year. Sometimes occurs in bermudagrass and other summer-growing grass pastures. Light grazing should be the rule during flowering and seed production periods if stands are to be maintained or increased. Strains naturalized in the South are often referred to as Augusta vetch.

Closely related to common vetch but is distinguishable by black pods, narrow leaflets, and smaller flowers.

Bigflower vetch.—Similar to other vetches in general habit of growth. It makes good winter growth. Like narrowleaf vetch, has a high percentage of hard seed and once established it volunteers from year to year. Exacting in fertility requirements; may not yield as well as narrowleaf on poor soils.

Harvested seed yields of both bigflower and narrowleaf are low because of severe seed shattering as the pods mature. Lack of commercial seed stocks of these two species has limited their use.

Purple vetch.—Very similar to hairy vetch but lacks winter hardiness. Yields well in zone A.

WINTER FIELD PEAS

Winter field peas are used primarily as soil-improving crops, although they may also be used for hay, pasture, and silage. When grown for hay, pasture, or silage they are usually seeded with oats or some other winter grain. Plants are viny; ascend only with support.

Austrian Winter variety is most winter hardy and most widely grown in the region. It is well adapted throughout zones A and B, and in southern part of zone C. Romack and Papago varieties are slightly less winter hardy. Both are well adapted in zones A and B, where they make more early growth than Austrian Winter. Dixie Wonder variety is least hardy of those discussed here and is adapted only in zone A and southern part of zone B.

COMMON AND SCIENTIFIC NAMES OF LEGUMES

Clovers, true	<i>Trifolium</i> spp.
Ball	<i>T. nigrescens</i>
Berseem	<i>T. alexandrinum</i>
Bigflower	<i>T. michelianum</i>
Buffalo	<i>T. reflexum</i>
Carolina	<i>T. carolinianum</i>
Cluster	<i>T. glomeratum</i>
Crimson	<i>T. incarnatum</i>
Hop	<i>T. agrarium</i>
Hop, large	<i>T. campestre</i> (<i>procumbens</i>)
Hop, small	<i>T. dubium</i>
Lappa	<i>T. lappaceum</i>
Persian	<i>T. resupinatum</i>
Rabbitfoot	<i>T. arvense</i>
Rose	<i>T. hirtum</i>
Striate	<i>T. striatum</i>
Subclover	<i>T. subterraneum</i>
(No approved common name)	<i>T. bejariense</i>
Lupines	<i>Lupinus</i> spp.
Blue	<i>L. angustifolius</i>
White	<i>L. albus</i>
Yellow	<i>L. luteus</i>
Medics, annual	<i>Medicago</i> spp.
Black medic	<i>M. lupulina</i>
Burclovers	
California	<i>M. hispida</i>
Cogwheel	<i>M. tuberculata</i>
Spotted (Southern)	<i>M. arabica</i>
Tifton	<i>M. rigidula</i>
Buttonclover	<i>M. orbicularis</i>
Roughpea	<i>Lathyrus hirsutus</i>
Serradella	<i>Ornithopus sativus</i>
Sweetclovers, annual	<i>Melilotus</i> spp.
White sweetclovers (Floranna, Hubam, and Israel varieties)	<i>M. alba annua</i>
Sourclover	<i>M. indica</i>
Tangier pea	<i>Lathyrus tingitanus</i>
Vetches	<i>Vicia</i> spp.
Bigflower	<i>V. grandiflora</i>
Common	<i>V. sativa</i>
Hairy	<i>V. villosa</i>
Hungarian	<i>V. pannonica</i>
Monantha	<i>V. articulata</i>
Narrowleaf (Augusta)	<i>V. angustifolia</i>
Purple	<i>V. bengalensis</i>
Smooth	<i>V. villosa</i> var. <i>glabrescens</i>
Woollypod	<i>V. dasycarpa</i>
Winter field peas	<i>Pisum arvense</i>